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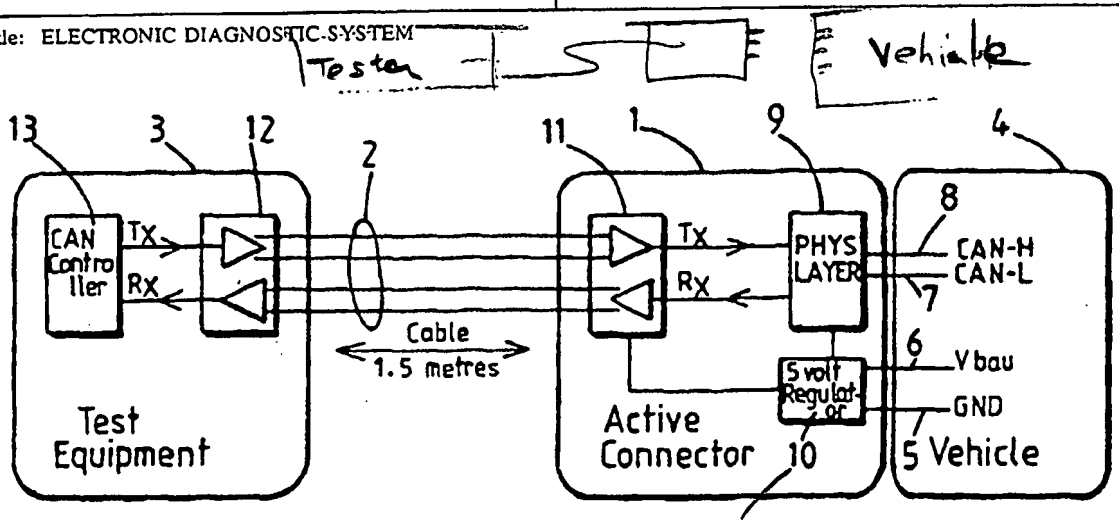
(54) Title: ELECTRONIC DIAGNOSTIC SYSTEM



(57) Abstract

A vehicle diagnostic system suitable for coupling to a CAN bus. The system has a connector which is coupled directly to the CAN bus and an analyser which is coupled to the connector by relatively long cables. A buffer is located in the connector to isolate the electrical load represented by the cable from the CAN bus and to communicate signals transmitted from the analyser to the bus and received from the bus to the analyser. Thus data can be read directly from the bus to conveniently located analysis equipment.

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ELECTRONIC DIAGNOSTIC SYSTEM

The present invention relates to a vehicle diagnostic system.

Modern vehicles incorporate complex electronic and electromagnetic active components such as engine management systems, fuel delivery control systems, and brake control systems. It is desirable that these active components intercommunicate and as a result it is now becoming conventional to equip vehicles with a serial data communication bus linking active vehicle components and in particular components known as Electronic Control Units (ECU's). There are several widely used serial communication protocols which are accepted as industry standards, one such high speed and high performance protocol being known as CAN (that is Controller Area Network). The term CAN bus is used herein to mean any bus linking active components of a vehicle and conveying data representative of the performance of those components.

It is conventional practice to communicate between diagnostic equipment and a vehicle over its diagnostic bus. However a CAN bus is not primarily intended for diagnostics and is not designed to allow for the connection of additional cable lengths to the vehicle's wiring system. The addition of a length of cable to a vehicle's CAN bus may cause data corruption.

The active components transmit to and receive data from the CAN bus to which they are connected at a high data rate, for example 1 Mbps. Such a high data rate ensures that the large volume of data can be handled, but also means that propagation delays on the bus must be minimised. Propagation delays of more than 20ns are not acceptable on a conventional CAN bus. Accordingly, each active element must be carefully designed to present no more than a predetermined electrical load to the bus.

In order to gain access to data on a CAN bus for diagnostic purposes, it is conventional practice to connect a gateway terminal to the bus. The gateway terminal is permanently connected to the bus and in effect represents an

additional active component. The gateway terminal monitors data on the CAN bus, and records fault conditions or other diagnostic related parameters. This diagnostic data may later be downloaded to appropriate diagnostic equipment. The data available at the output of the gateway terminal is limited in scope as compared with that on the bus, the nature of the data being determined largely by regulatory demands, e.g. regulations imposed by particular political bodies. Typically a gateway terminal is designed to meet an agreed standard such as ISO9141. Unfortunately, although regulations may change over the life of a vehicle, it is not possible to readily modify a gateway terminal to reflect such changes. Furthermore, problems can arise in a vehicle which cannot be readily diagnosed using the signals output by a conventional gateway terminal, especially where the data rate on the vehicle side of the gateway is much higher than that on the output side of the gateway.

A CAN bus is generally in the form of a twisted pair cable linking the active components. It is sometimes desirable to connect diagnostic equipment to the cable to gain direct access to the data on the bus rather than relying upon a gateway terminal. Unfortunately, diagnostic equipment is generally located in cabinets and cannot readily be positioned close to a vehicle under test. It has been discovered by the applicants that it is not possible to connect a cable between a CAN bus and a remote diagnostic station as signal reflections arise which result in corruption of data on the bus. In a typical CAN system the maximum acceptable length of a stub connection to the bus is limited to 30 centimetres. This makes a direct connection between a CAN bus and many types of diagnostic equipment impractical.

According to present invention, there is provided a vehicle diagnostic system comprising a connector which may be coupled to a CAN bus, and an analyser incorporating test equipment linked to the connector by a cable, wherein the connector comprises a buffer located between the bus and the cable to isolate the electrical load represented by the cable from the bus and to

communicate signals transmitted from the analyser to the bus and received from the bus to the analyser.

Preferably the buffer comprises a converter circuit arranged to interface bi-directional signals on the buffer with unidirectional transmit and receive signals. The buffer and analyser each comprise a linedriver and receiver circuit arranged to convert signals from the buffer convertor and test equipment to a protocol suitable for transmission on a cable, and to convert signals from the cable to signal suitable for applications to the buffer convertor and test equipment.

The test equipment used can be of conventional form, as can the buffer converter circuit, the novelty lying in the separation of these two components such that one of the components is in the connector at one end of the cable and the other component is in the analyser at the other end of the cable. The linedriver and receiver circuit ensure that data is not corrupted during its transmission through the cable. The signals from the test equipment and the buffer converter may be converted to RS422 levels for transmission along the cable.

An embodiment of the present invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a schematic illustration of an embodiment of the present invention; and

Figure 2 illustrates the components provided in the connector of figure 1.

Referring to figure 1, a connector 1 is coupled by a four conductor cable to an analyser 3. The connector is linked to a vehicle 4 by four conductors, conductor 5 being connected to the vehicle ground, conductor 6 being connected to the vehicle battery, conductor 7 being connected to the "low" cable of a CAN bus, and conductor 8 being connected to the "high" conductor of a CAN bus. As is conventional, the voltage levels on the CAN bus will be analogue, typically 2.5 volts when passive and 3.5 volts on the "high" wire and 1.5 volts on the "low" wire when dominant.

The connector 1 in effect comprises a buffer to isolate the CAN bus from the electrical load represented by the cable 2. A circuit 9 powered by a simple voltage regulator 10 converts the bi-directional signals on the CAN bus into transmit (TX) and receive (RX) unidirectional digital signals. These digital signals are then buffered by conversion to RS422 levels by a differential linedriver/receiver circuit 11 which is also powered by the voltage regulator 10.

The analyser comprises a differential linedriver and receiver circuit 12 which is identical to the circuit 11. Transmit and receive signals are passed between the circuit 12 and a conventional CAN controller. Any suitable test equipment could however be connected to the transmit and receive lines of the circuit 12.

It will be appreciated that data derived from the CAN bus by the circuits in the connector 1 can be transmitted considerable different distances over the cable to any conveniently located test equipment. Thus data relevant to the operation of the vehicle can be derived without it being necessary to move the test equipment to close proximity with the CAN bus itself.

Referring to figure 2, the same reference numerals are used as were used with reference to figure 1. The conductors 7 and 8 are connected to a PCA82C250 chip corresponding to the circuit 9 of figure 1 and that chip is connected to a DS89C21TN chip corresponding to the linedriver and receiver circuit 11 of figure 1. The four wires 2 connected to the circuit 11 correspond to cable 2 of figure 1. The chips referred to are readily available components and familiar to engineers with knowledge of CAN bus systems.

CLAIMS

1. A vehicle diagnostic system comprising a connector which may be coupled to a CAN bus, and an analyser incorporating test equipment linked to the connector by a cable, wherein the connector comprises a buffer located between the bus and the cable to isolate the electrical load represented by the cable from the bus and to communicate signals transmitted from the analyser to the bus and received from the bus to the analyser.

2. A system according to claim 1, wherein the buffer comprises a converter circuit arranged to interface bi-directional signals on the bus with unidirectional transmit and receive signals, and the buffer and analyser each comprise a line driver and receiver circuit arranged to convert signals from the buffer converter and test equipment to a protocol suitable for transmission on the cable, and to convert signals from the cable to signals suitable for application to the buffer converter and test equipment.

3. A vehicle diagnostic system substantially as hereinbefore described with reference to accompanying drawings.

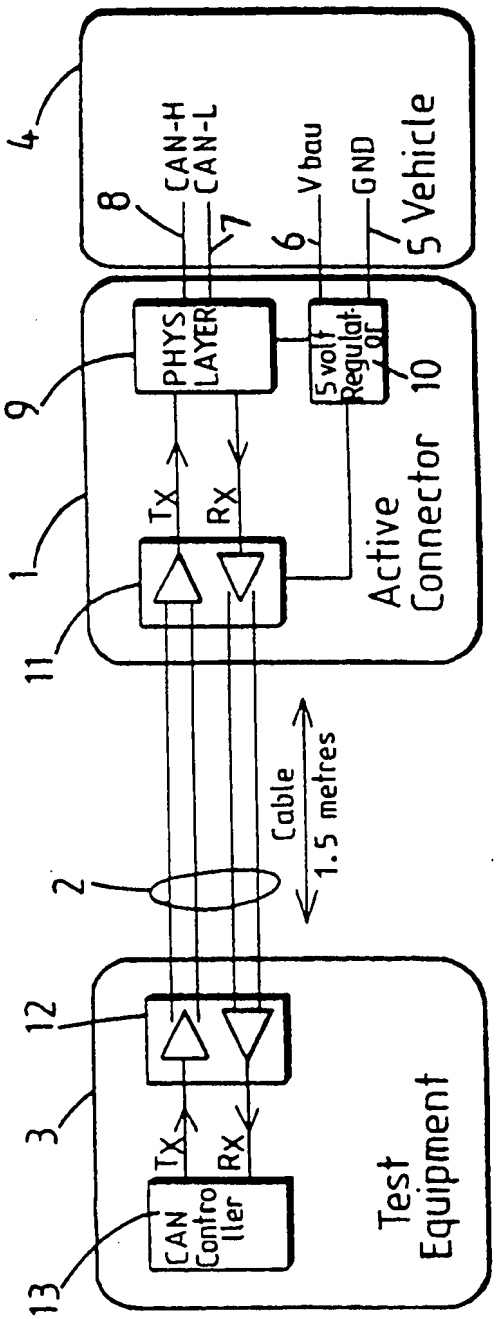

FIG.1

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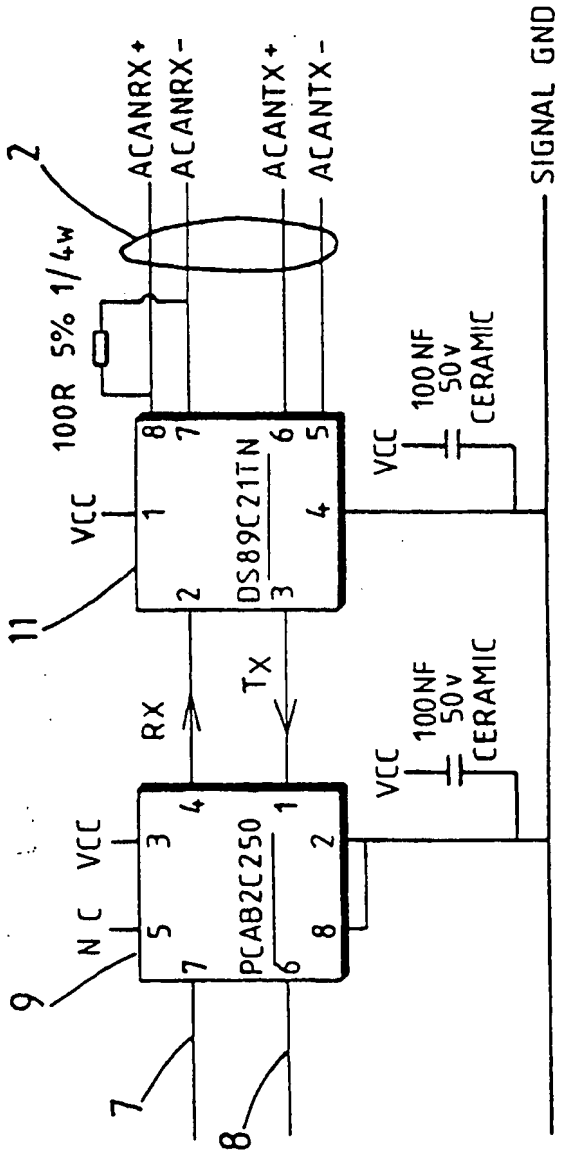

FIG. 2

INTERNATIONAL SEARCH REPORT

International Application No
PCT/GB 96/01621

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 G07C5/08 B60R16/02 G01R31/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 G07C B60R B60T G01R H01R

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE,A,43 00 661 (LAWRENZ WOLFHARD) 14 July 1994 see column 1, line 10 - column 2, line 53 see column 3, line 11 - column 4, line 4; figures ---	1-3
A	WO,A,91 02256 (BOSCH GMBH ROBERT) 21 February 1991 see page 3, line 6 - page 4, line 17 see page 5, line 20 - line 35; figures ---	1
A	DE,A,41 14 921 (AHLBORN MESS UND REGELUNGSTECH) 12 November 1992 see abstract; claims 1-6; figures see column 4, line 27 - column 5, line 24 --- -/--	1

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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